Level3 Measurement of "Shoubu System B"

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ExaScaler Inc.
Sunao Torii
PEZY Computing K.K.
Ryo Sakamoto

Executive Summary

Comparison between now and then

Shoubu SystemB	Nov. 2018	June 2018
Rmax (GFLOPS)	**1063.3TFLOPS**	857.6TFLOPS
Nmax (Matrix Size)	1,904,640	1,388,800
Num. of Nodes	**60**	50
Node CPU Memory	64GB	32GB
GFLOPS/W	17.6	18.4
Measurement Quality	**Level3**	Level1
Measurement Nodes	Full (60)	Partial (20)
Measurement NW comp.	Full (2)	Full (2)
Including internal cooling device	**Yes** (Coolant Circulation Pump and Valve)	No
Including storage device	No (Not Use in HPL)	
Efficiency Enhancement	Liquid Temp. Optimizing	N.A

Our Motivation

- Maintain #1 place of Green500 List

  Rmax performance within TOP500 List is required.

  Boosting Rmax performance

  Our target is Rmax over 1.0 Peta FLOPS.

- Level 3 quality power measurement

  Some people say, “Are ExaScaler machines really energy efficient?” and I promised, we will try Level2 or 3 next time.

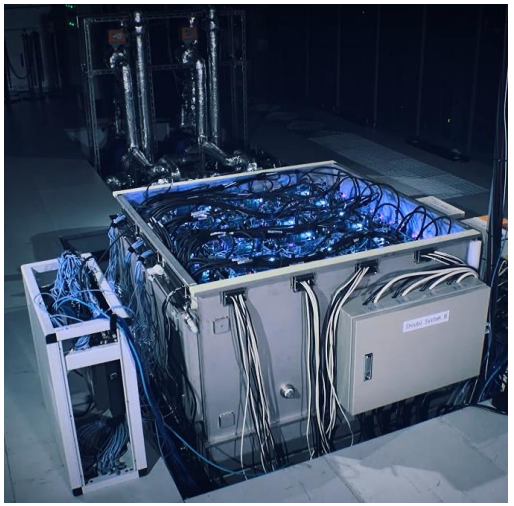
  Whole system power consumption is measured.

  Coolant Temperature optimization is added.

Agenda

- Executive Summary of latest TOP500 measurement
- Our motivation
- How to Performance boost
- Level1 & Level3 measurement
- Cooling power optimization
- Estimated PUE of Shoubu System B
- Collaboration progress
- Conclusion

How to performance boost

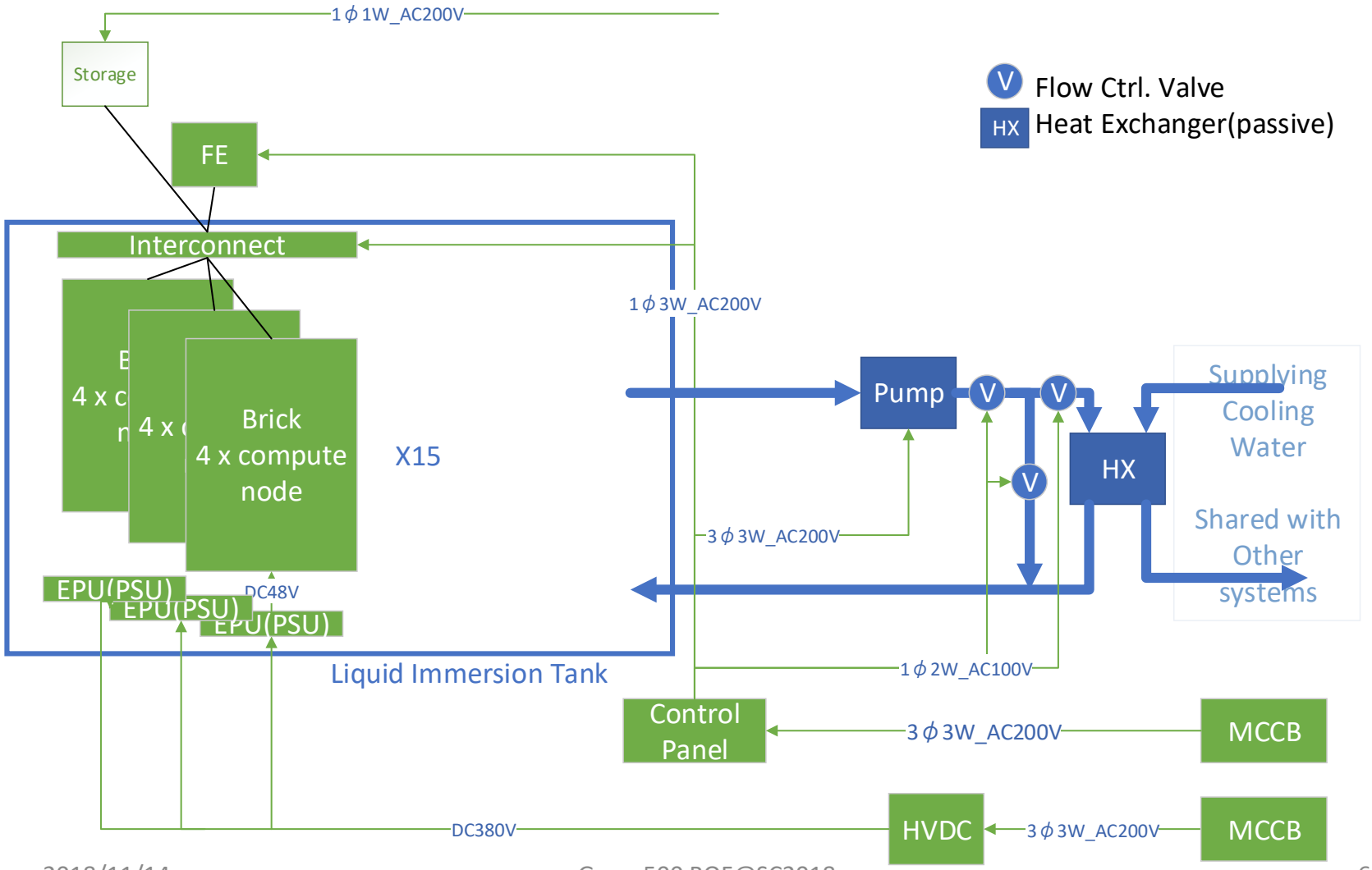


- Increasing the number of Nodes
  - Previous: 50nodes
  - Current: 60nodes

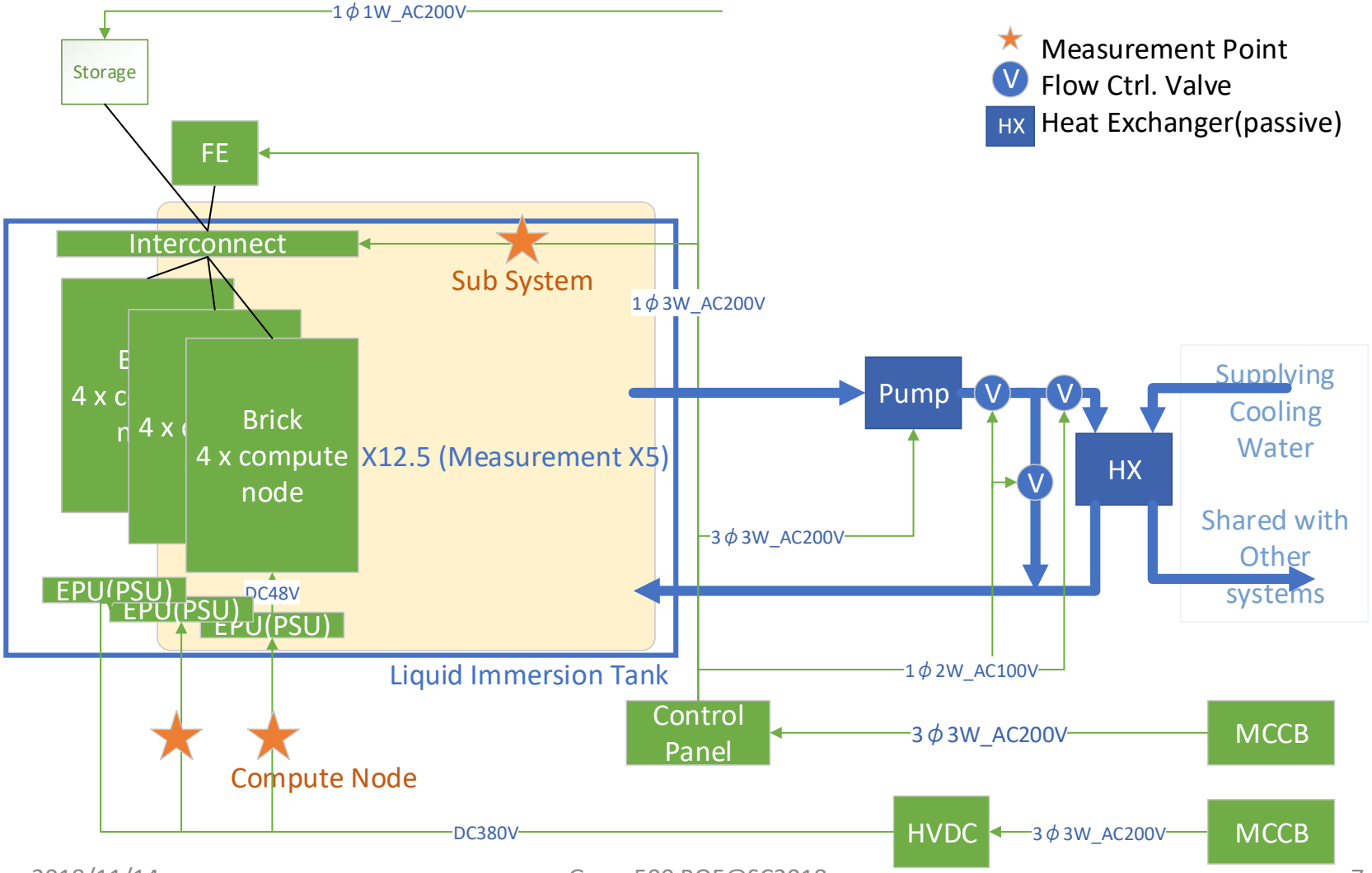
- Expanding Nmax(Matrix size)
  - Previous: 1,388,800 -> 69,440x69,440 / Each Accelerator (PEZY-SC2)
  - Current: 1,904,640 -> 79,360x79,360 / Each Accelerator (PEZY-SC2)

  To realize them, Node CPU memory is enlarged from 32GB to 64GB

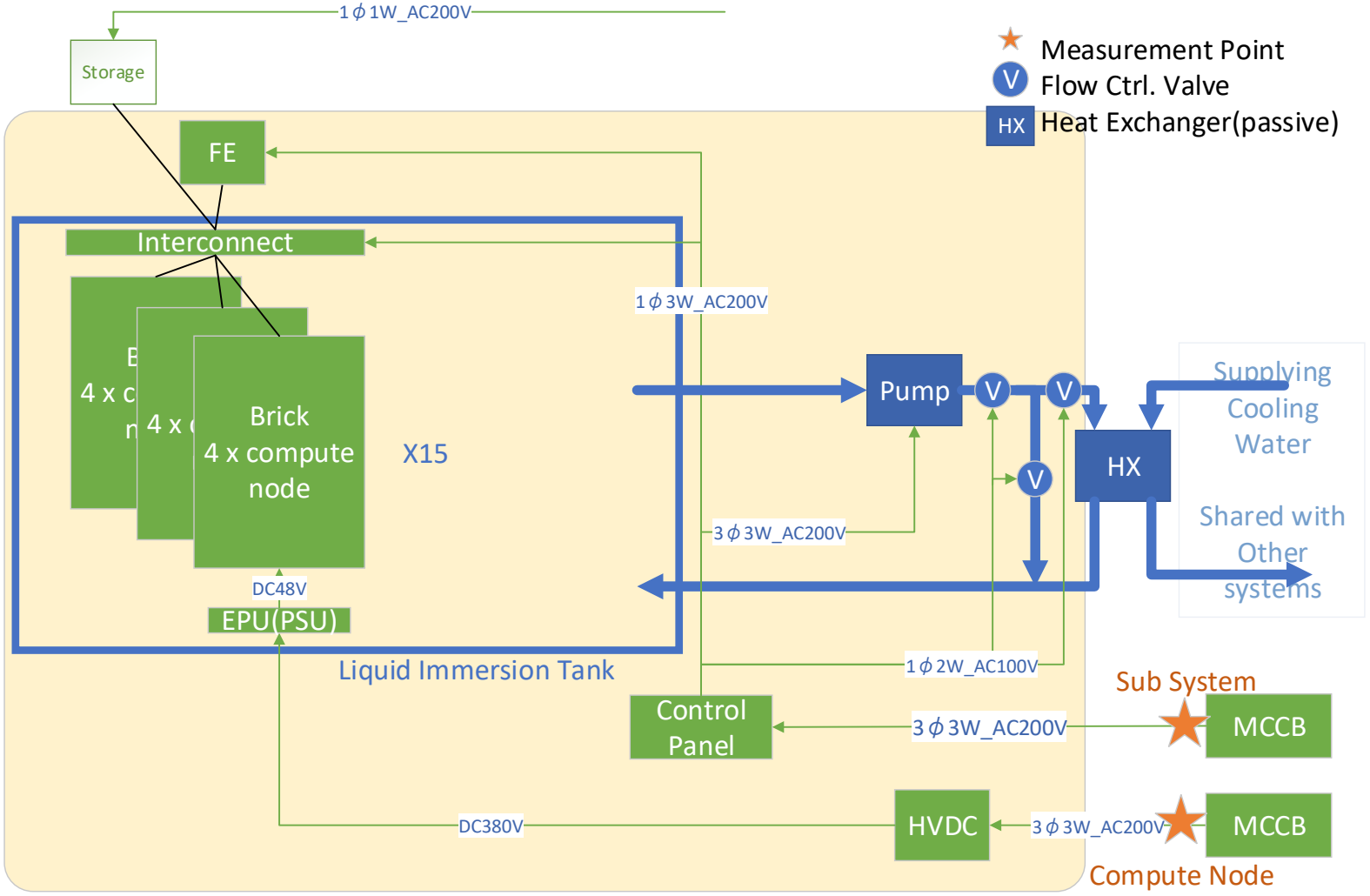
Shoubu System B block diagram



Level1 Measurement



Level3 Measurement

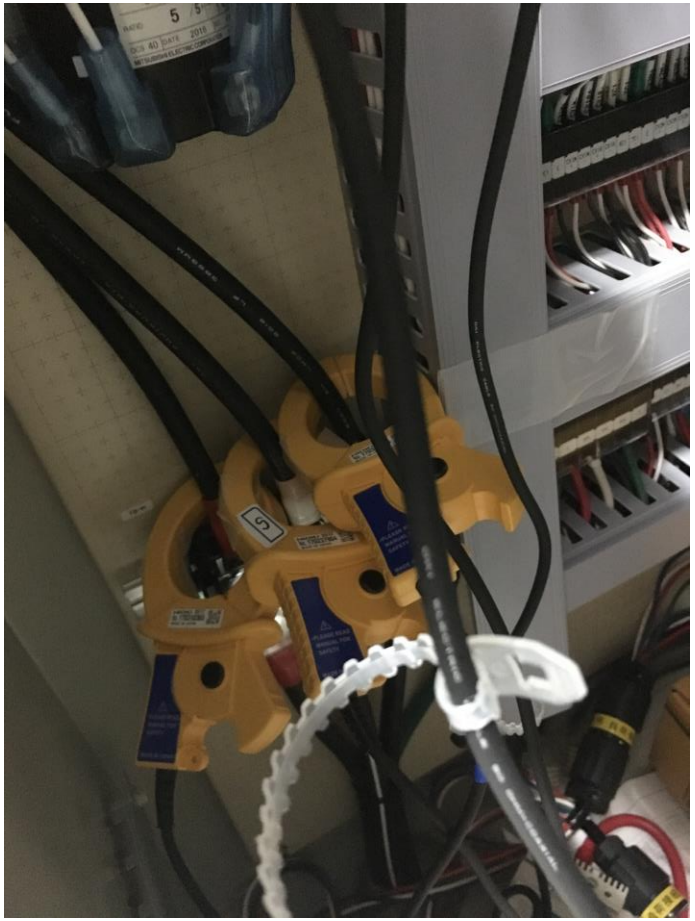


Level3 Measurement Pictures

Compute Node @ Input point of HVDC

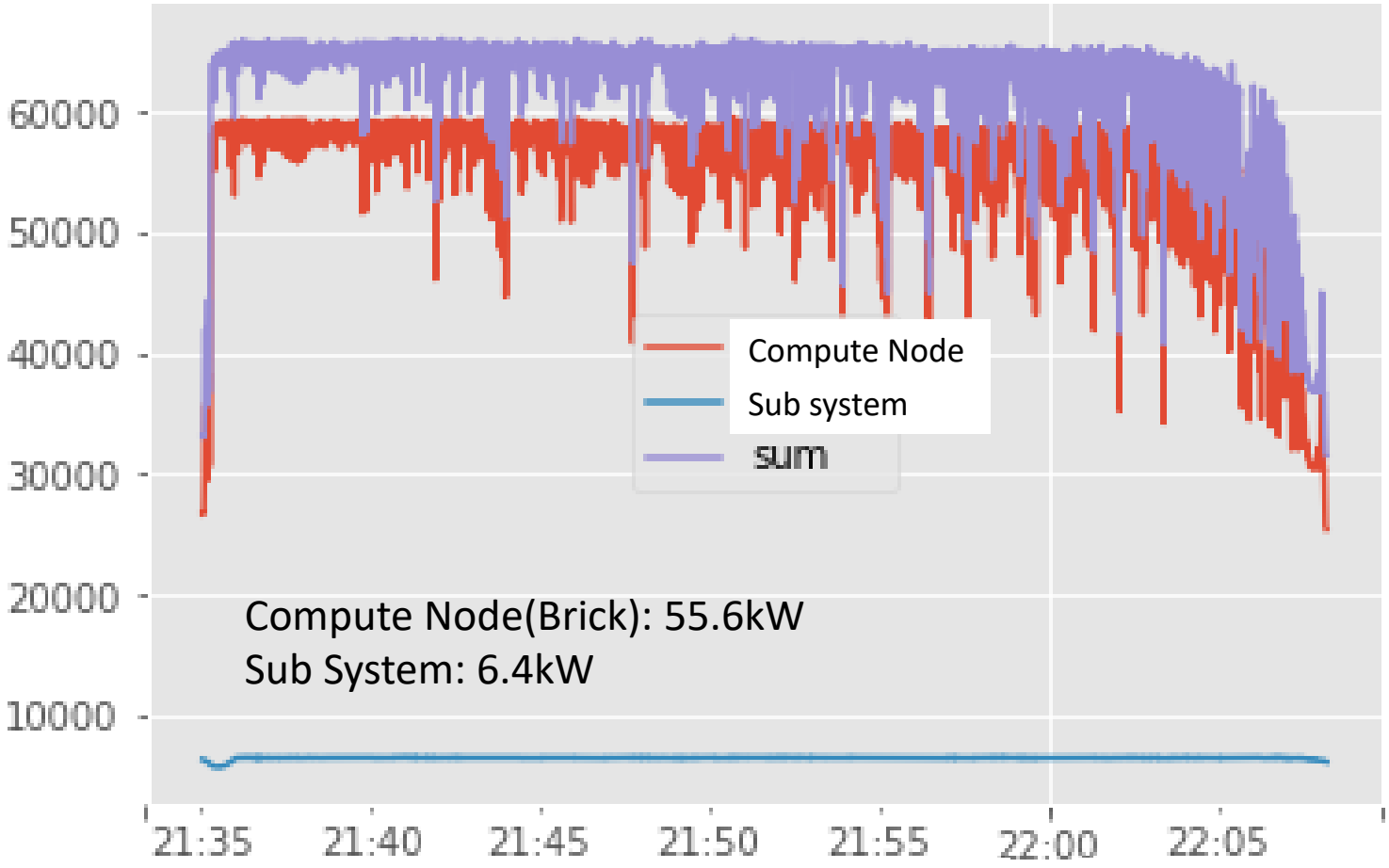
Clump sensors are used at all measurement points

Sub-sytems@ In MCCB



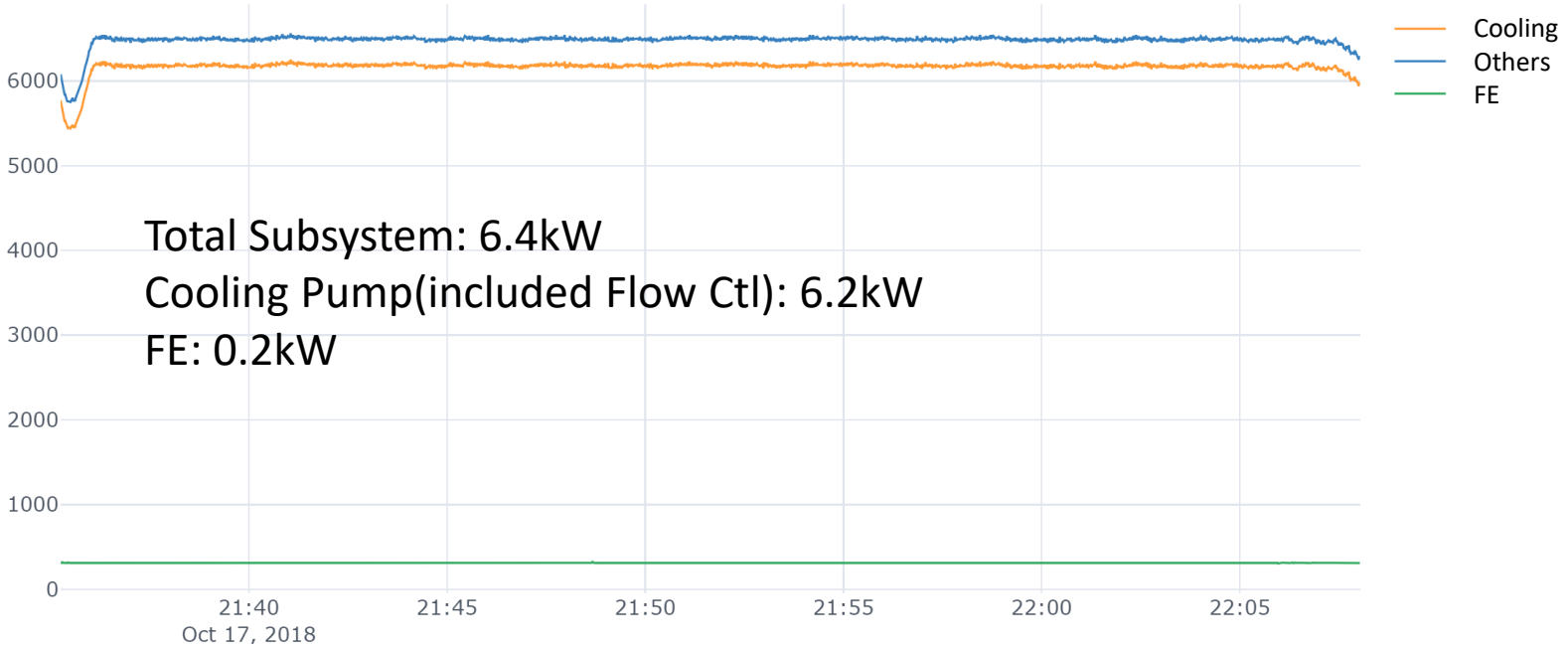
1st Measurement result

15.99GF/W@Level3, 17.90GF/W@Level1



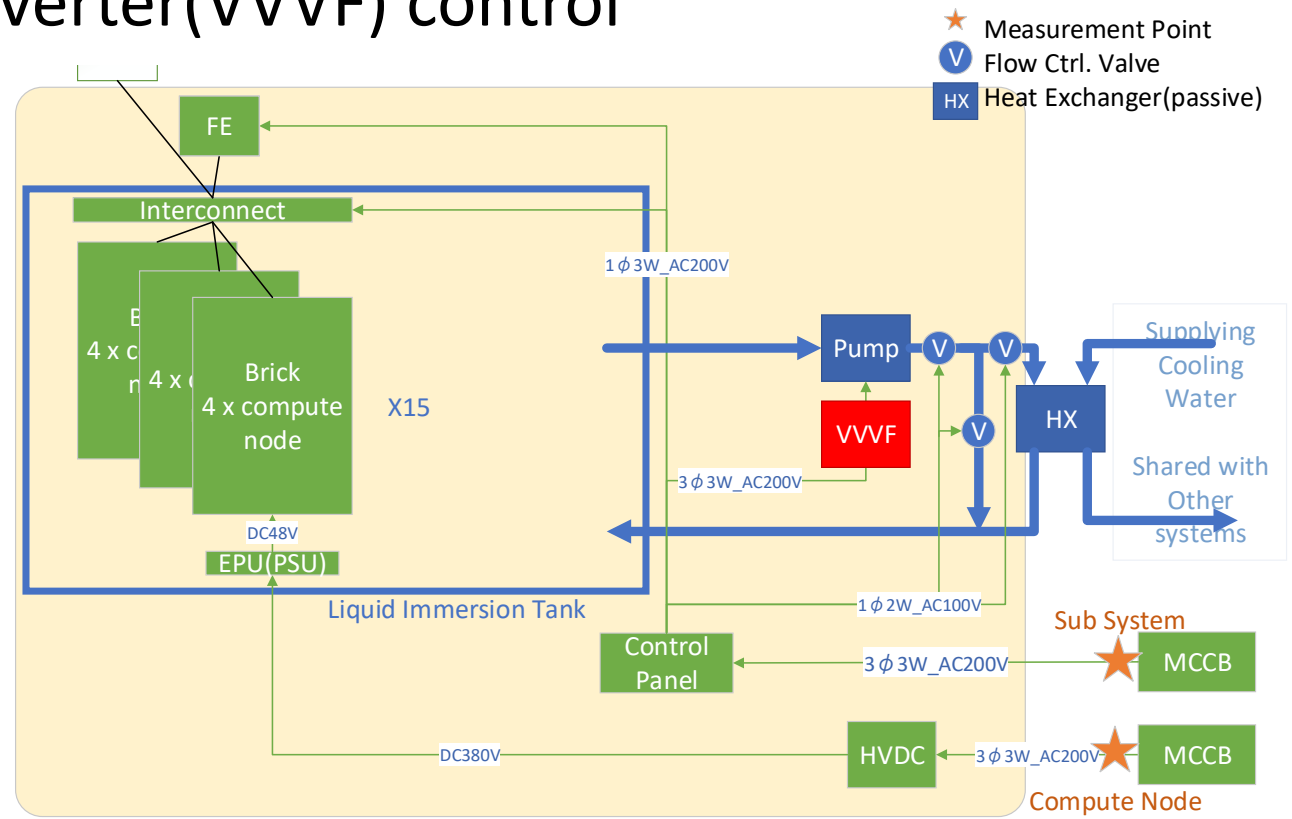
Breakdown of subsystem power

Cooling pump is using power allmost all in subsystems.



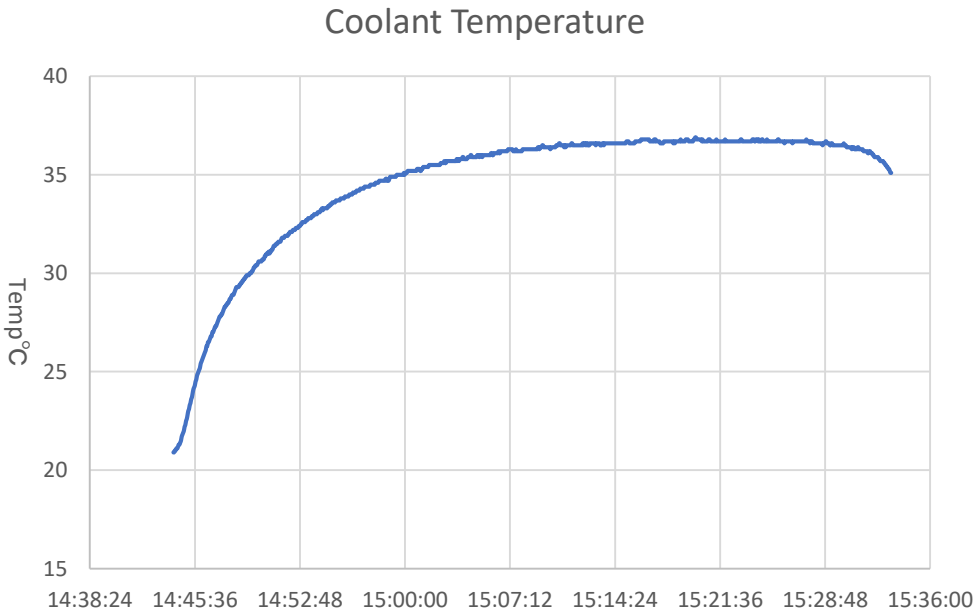
Cooling power optimization

- Reduction of Pump Power
  Add Inverter(VVVF) control



Cooling power optimization

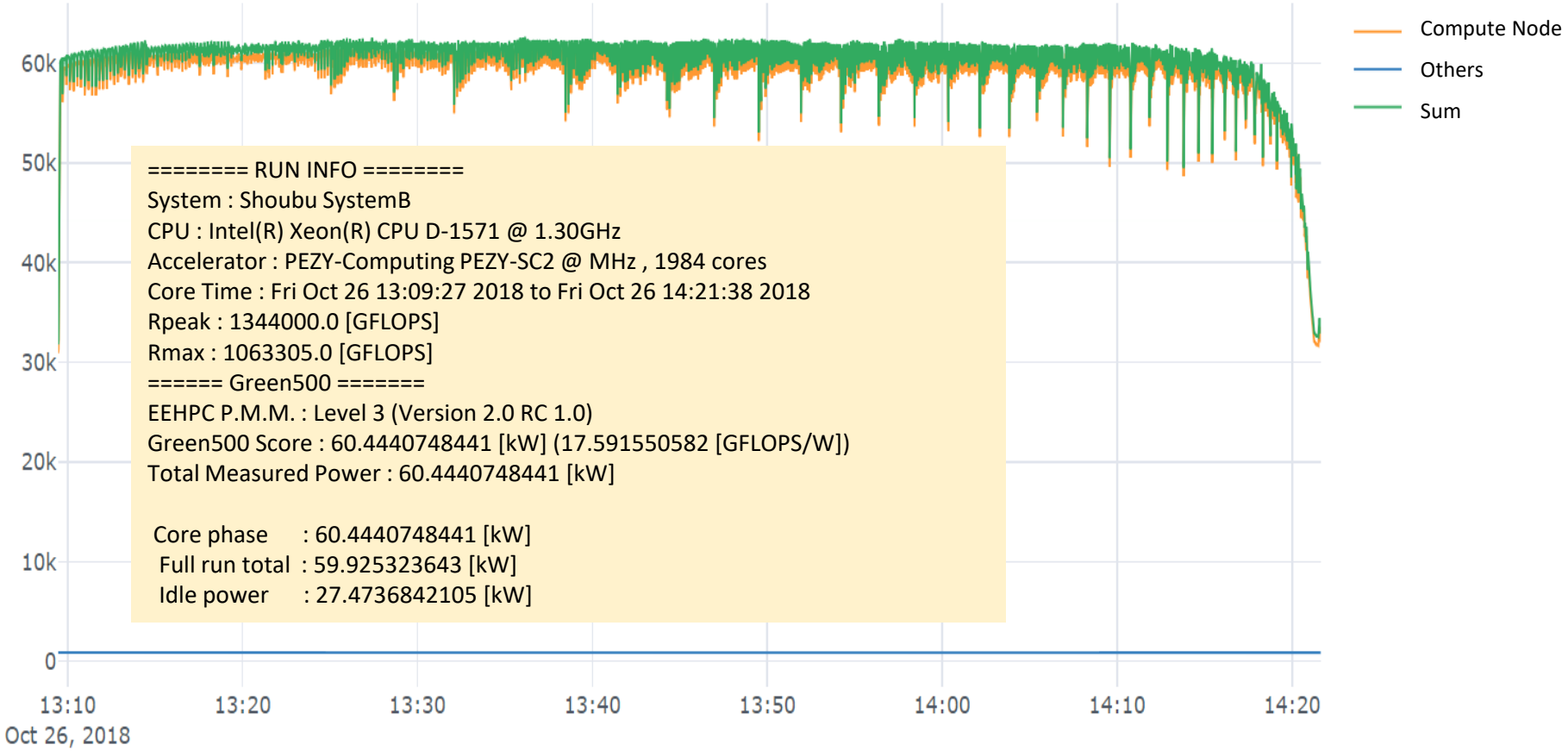
- Coolant circulation speed is controlled to keep around 35℃ during Core phase.
  Freq: 50Hz to 17Hz



Total Subsystem: 0.7kW
Cooling Pump(+inv, flow ctl): 0.5kW
FE: 0.2kW

Final Measurement result

17.6 GFlops/W @ Level 3



PUE (Power Usage Effectiveness)

= (cooling + server power) / (server power)

- System Internal PUE : (0.5+59.9)/59.9 = 1.01
- Estimated Total PUE including facilities is around 1.2
  - Chilling water is generated by ACCS facilities
    - RIKEN ACCS COP is around 4-5 in October.
      COP: Coefficient Of Performance
    - Combine Turbo-chiller, Free-Cooling Tower, and well water
    - Shared with HOKUSAI, AHU and ShoubuB

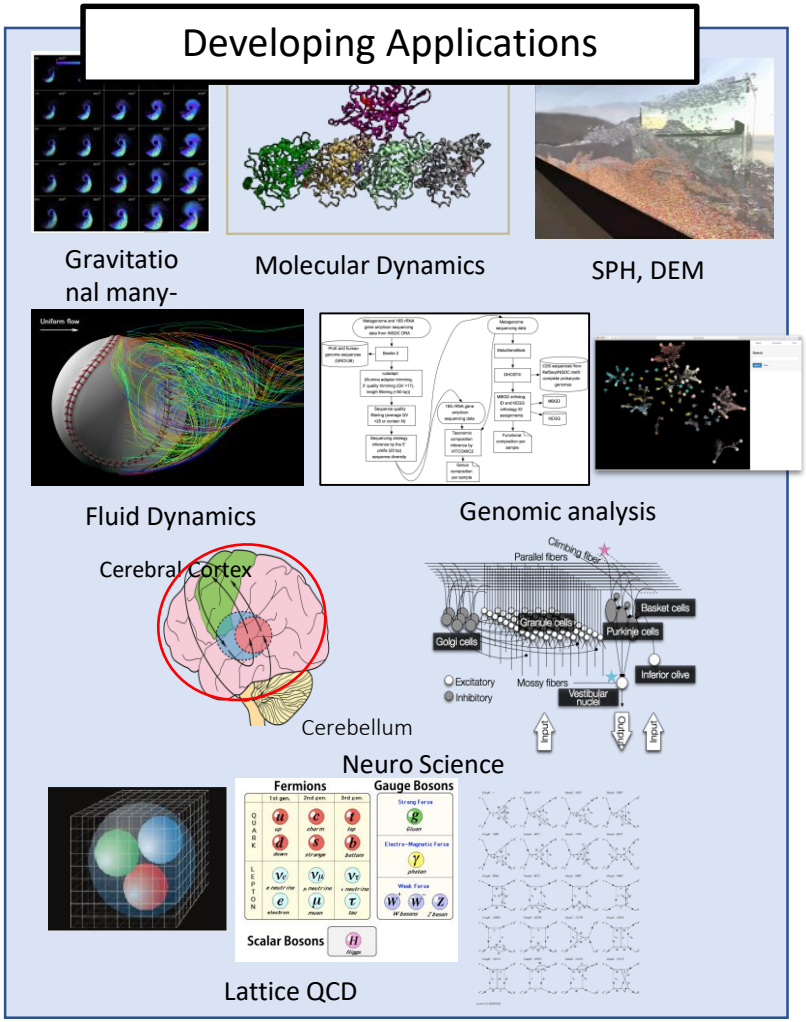
	Air Cooling	Liquid Immersion
On board Fan Power	Accumulated to server power	Not Required
Leakage Power	High(Hi-temperature)	Low(Low-temperature)
Absolute Total Power	High	**Low**
PUE at same calculation	Lower(Advantageous)	Higher(Dis-advantageous)

Collaboration: Heterogeneous Many Core Project
Large-Scale Computational Science on Heterogeneous Many Core Computers

Visit Booth: 821

We have been done:

1. MD Simulation of Water
   - Measured effective performance 3.8PFLOPs(10.6%) on Gyoukou
2. Simulation of Rings of Saturn
   - Measured effective performance 47.9PFLOPs(40%) on SunwayTaihuLight
   - 10.6PFLOPs(23.5%) on Gyoukou
3. Simulation of Compressible Flow Using "FORMULA"
   - Measured effective performance 4.78PFLOPs(21.5%) on Gyoukou
4. Real Time Simulation of Cerebellum of Macaca
   - Realize Cerebellum of Macaca using 8 billion neuron and synapse and simulate learning process of eye movement.
   - Measured effective performance 1.85PFLOPs on Gyoukou
5. Accelerate Homology Analysis for Bacteria analysis in Flora
   - About 10-100 times speed up
6. Double double precision operation in BLAS (Rgemm)
   - 76% of peak performance

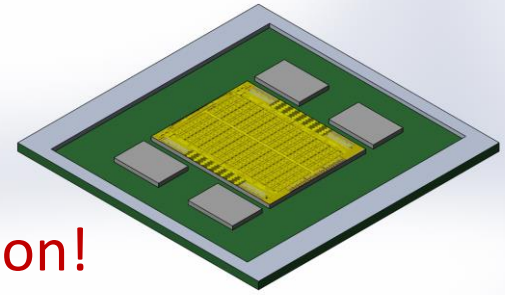


ExaScaler PEZY Computing

Level3 Measurement is not so difficult for such under 100KW scale machines.

- Understanding the regulation is not so easy.
- Great help to find out hiding overhead.

We never stop developing MOST power efficient supercomputer!



PEZY-SC3 coming soon!